

CURRENT LISTING OF CLAIMS

1. (Currently amended) Apparatus for automating the production of a radiopharmaceutical by executing a sequence of process flow operations, said apparatus comprising:

a workstation having a processing component programmed to execute a process including the steps of:

providing a recipe editor for creating and maintaining a recipe, and

providing operations control for executing said recipe;

a controller having an input/output component and a processing component, said controller communicating with said workstation, said controller processing component programmed to execute a process including the steps of:

receiving a plurality of unit operations forming said recipe, each said unit operation describing a chemical process step,

executing said plurality of unit operations; and

process hardware in communication with said input/output component of said controller, said process hardware adapted to produce the radiopharmaceutical and including a reagent delivery system and a reaction vessel with an associated heating and purging system;

wherein said step of executing said plurality of unit operations includes the steps of:
executing one of said plurality of unit operations and starting a parallel group,
classifying a next one of said plurality of unit operations as one of a parallel operation and a sequential operation,

executing said parallel operation as part of said parallel group and repeating said step of classifying,

waiting for said parallel group to complete execution,

executing said sequential operation and starting a new parallel group, and
repeating said step of classifying.

2. (Original) The apparatus of claim 1 wherein each of said plurality of unit operations describes a process flow step in terms of the chemical and physical steps to be performed.

3. (Original) The apparatus of claim 1 wherein each of said plurality of unit operations calls a software routine programmed to perform a set of instructions to manipulate said plurality of process hardware to perform a process flow step.

4. (Original) The apparatus of claim 1 wherein said workstation communicates said recipe and at least one command to a process control program being executed by said controller.

5. (Original) The apparatus of claim 1 wherein a process control program being executed by said controller communicates a recipe state and at least one device state to said workstation.

6. (Original) The apparatus of claim 1 wherein said process step of providing operations control being executed by said workstation processing component includes the steps of: selecting said recipe for execution from a library, sending said recipe to said controller, and sending an execute command to said controller.

7. (Original) The apparatus of claim 6 wherein said step of sending said recipe includes sending said plurality of unit operations to said controller.

8. (Original) The apparatus of claim 6 wherein said process step of providing operations control further includes the step of receiving a stream of data from said controller, said stream of data including a recipe state, at least one unit operation state, and at least one device state.

9. (Original) The apparatus of claim 6 wherein said process step of providing operations control further includes sending a reset command to said controller before said step of sending said recipe to said controller.

10. (Original) The apparatus of claim 1 wherein said controller processing component is programmed to execute a process further including receiving a reset command and initializing said controller before said step of receiving said plurality of unit operations.

11. (Original) The apparatus of claim 1 wherein said controller processing component includes a process control program and a hardware control program, said process control program including a step of communicating with said hardware control program.

12. (Original) The apparatus of claim 1 wherein said controller processing component includes a process control program and a hardware control program, said hardware control program having a plurality of instructions executable by the controller, said hardware control program including a step of communicating with said process control program and a step of communicating with said plurality of process hardware.

13. (Original) The apparatus of claim 1 wherein said controller processing component includes a process control program and a hardware control program, said process control program having a lookup table correlating each of said plurality of input/output points to a corresponding device, said process control program receiving data from one of said plurality of input/output points and said process control program executing a step to determine said corresponding device.

14. (Original) The apparatus of claim 1 wherein said controller processing component includes a process control program and a hardware control program, said hardware control program having a lookup table correlating each of said plurality of devices to each of said input/output points whereby said hardware control program

receives instructions to be communicated to one of said plurality of devices and said hardware control program executes a step to determine said corresponding input/output point.

15. (Original) The apparatus of claim 1 wherein said controller processing component includes a process control program and a hardware control program, said hardware control program having a plurality of instructions executable by said controller processing component for data acquisition from a plurality of selected devices of said plurality of process hardware, and said hardware control program sending a plurality of acquired information to said process control program.

16. (Previously presented) A method for automating a sequence of process flow operations, said method comprising:

- receiving a recipe by a process control module, said recipe including a plurality of unit operations, each of said plurality of unit operations describing a process flow step in terms of at least one chemical and/or physical step to be performed;

- executing said plurality of unit operations including the steps of:

- executing one of said plurality of unit operations and starting a parallel group,

- classifying a next one of said plurality of unit operations as one of a parallel operation and a sequential operation,

- executing said parallel operation as part of said parallel group and repeating said step of classifying,

- waiting for said parallel group to complete execution,

- executing said sequential operation and starting a new parallel group, and

- repeating said step of classifying.

17. (Original) The method of claim 16 wherein each of said step of executing said parallel operation and said step of executing said sequential operation includes the step of passing a set of data from said process control module to a hardware control module, said hardware control module performing a set of instructions to manipulate a plurality of process hardware to perform a process flow step.

18. (Original) The method of claim 16 further including a step of communicating a recipe state, at least one unit operation state, and at least one device state to a workstation.

19. (Original) The method of claim 16 further including a step of receiving a reset command and initializing the computer system before said step of receiving said recipe.

20. (Original) The method of claim 16 wherein said process control module communicates with a hardware control module responsible for providing an interface to a plurality of process hardware.

21. (Original) The method of claim 16 wherein said execution loop further includes a step of correlating one of a plurality of input/output points with one of a plurality of hardware devices, thereby allowing said process control module to communicate with a hardware control module.

22. (Original) The method of claim 16 wherein said execution loop further includes a step of correlating one of a plurality of hardware devices with one of a plurality of input/output points, thereby allowing a hardware control module to communicate with said process control module.

23. (Original) The method of claim 16 further including a step of performing data acquisition from a plurality of selected devices of a plurality of process hardware, said step of performing data acquisition performed by a hardware control module, sending a plurality of acquired information to said process control module from a hardware control module.

24. (Previously presented) A computer system for automating a sequence of process flow operations, said computer system comprising:

a controller having an input/output component and a processing component, said input/output component for communicating with a workstation and process hardware, said processing component programmed to execute a process including the steps of:

receiving a recipe, said recipe including a plurality of unit operations, each of said plurality of unit operations describing a process flow step in terms of at least one chemical and/or physical step to be performed;

executing said plurality of unit operations including the steps of:

executing one of said plurality of unit operations,

determining if a next one of said plurality of unit operations is executable in parallel with said one of said plurality of unit operations and, if so, executing said next one of said plurality of unit operations and repeating said step of determining until said next one of said plurality of unit operations is determined not to be executable in parallel, and

waiting for execution of said one of said plurality of unit operations to be completed if said next one of said plurality of unit operations is determined not to be executable in parallel with said one of said plurality of unit operations.

25. (Original) The computer system of claim 24 wherein said step of executing one of said plurality of unit operations includes a step of passing a set of data to a hardware control module from a process control module, executing a set of instructions by said hardware control module to manipulate said plurality of process hardware to perform said process flow step defined by said one of said plurality of unit operations.

26. (Original) The computer system of claim 24 further including said workstation having a processing component, said workstation processing component programmed to execute a process including the steps of: providing a recipe editor for creating and maintaining said recipe, providing operations control for executing said recipe, and displaying at least one process variable during execution of said recipe.

27. (Original) The computer system of claim 24 further including said plurality of process hardware in communication with said input/output component of said controller

and responsive to at least one control signal transmitted by said controller, said plurality of process hardware adapted to produce a radiopharmaceutical and including a reagent delivery system and a reaction vessel with an associated heating and purging system.

28. (Original) The computer system of claim 24 wherein said workstation communicates said recipe and at least one command to a process control program being executed by said controller.

29. (Original) The computer system of claim 24 wherein a process control program being executed by said controller communicates a recipe state, at least one unit operation state, and at least one device state to said workstation.

30. (Original) The computer system of claim 24 wherein said controller processing component is programmed to execute a process further including a step of receiving a reset command and initializing said controller before said step of receiving said plurality of unit operations.

31. (Original) The computer system of claim 24 wherein said processing component further executes a process step including correlating each of a plurality of input/output points to a corresponding one of a plurality of hardware devices whereby said process control module receives data from one of said plurality of input/output points and said process control module determines said corresponding one of said plurality of hardware devices.

32. (Original) The computer system of claim 24 wherein said processing component further executes a process step including correlating each of a plurality of hardware devices to a corresponding one of a plurality of input/output points whereby a hardware control module determines said corresponding one of said plurality of input/output points and said hardware control module communicates with one of said plurality of input/output points.

33. (Original) The computer system of claim 24 wherein said processing component further executes a process step including performing data acquisition from a plurality of selected devices of said plurality of process hardware, said step of performing data acquisition performed by a hardware control module, said hardware control module sending a plurality of acquired information to said process control module.

34. (Previously presented) A controller for automating a sequence of process flow operations, said controller comprising:

- an input/output component adapted to communicate with a workstation and process hardware; and

- a processing component programmed to execute a process including the steps of:

 - receiving a recipe including a plurality of unit operations, each of said plurality of unit operations describing a process flow step in terms of at least one chemical and/or physical step to be performed;

 - executing said plurality of unit operations including the steps of:

 - executing one of said plurality of unit operations and starting a parallel group,

 - classifying a next one of said plurality of unit operations as one of a parallel operation and a sequential operation,

 - executing said parallel operation as part of said parallel group and repeating said step of classifying,

 - waiting for said parallel group to complete execution,

 - executing said sequential operation and starting a new parallel group, and

 - repeating said step of classifying.

35. (Original) The controller of claim 34 wherein said step of executing one of said plurality of unit operations, said step of executing said parallel operation, and said step of executing said sequential operation each including a step of passing a set of data to a hardware control module from a process control module, said hardware control module executing a set of instructions including a step of manipulating said plurality of process hardware to perform said process flow step.

36. (Original) The controller of claim 34 wherein a process control program being executed by said controller communicates a recipe state, at least one unit operation state, and at least one device state to a workstation.

37. (Original) The controller of claim 34 wherein said a process further includes receiving a reset command and initializing said controller before said step of receiving said recipe.

38. (Original) The controller of claim 34 further including the step of storing said recipe in a queue after said step of receiving said recipe.

39. (Original) The controller of claim 34 further including a correlating one of a plurality of devices to one of a plurality of input/output points, whereby a set of data is passed between a process control program and a hardware control program, said process control program dealing with said plurality of devices and said hardware control program dealing with said plurality of input/output points.

40. (Original) The controller of claim 34 wherein said processing component further includes a step for data acquisition from a plurality of selected devices of said plurality of process hardware.

41. (Currently amended) A controller for automating a sequence of process flow operations, said controller comprising:

- an input/output component adapted to communicate with a workstation and process hardware;

- a process control program for executing a recipe including a plurality of unit operations, each of said plurality of unit operations describing a process flow step in terms of at least one chemical and/or physical step to be performed, said process control program receiving said recipe through said input/output component;

a hardware control program for monitoring and controlling said process hardware through said input/output component, said process control program communicating with said hardware control program; and

a processing component programmed to execute said process control program and said hardware control program;

wherein said process control program is programmed to execute a process including the steps of: receiving said plurality of unit operations, each of said plurality of unit operations describing a process flow step in terms of at least one chemical and/or physical step to be performed; receiving a command to begin execution of said recipe, performing an execution loop wherein said plurality of unit operations are executed, said execution loop including the steps of:

executing one of said plurality of unit operations and starting a parallel group, classifying a next one of said plurality of unit operations as one of a parallel operation and a sequential operation, executing said parallel operation as part of said parallel group and repeating said step of classifying, waiting for said parallel group to complete execution, executing said sequential operation and starting a new parallel group, and repeating said step of classifying.

42. (Cancelled)

43. (Original) The controller of claim 41 wherein said hardware control program is programmed to execute a process including the steps of: receiving a set of values from said process control program; sending a set of data to a selected device of said plurality of process hardware, said set of data corresponding to said set of values.

44. (Original) The controller of claim 41 wherein said hardware control program is programmed to execute a process including the steps of: receiving a set of data from a selected device of said plurality of process hardware; sending a set of values to said process control program, said set of data corresponding to said set of values.

45. (Original) The controller of claim 41 wherein said process control program includes a plurality of process objects representing a plurality of process elements, each of said plurality of process objects including at least one property and at least one method for manipulating one of said plurality of process elements.

46. (Original) The controller of claim 41 wherein said hardware control program includes a plurality of hardware objects each representing a hardware device from said plurality of process hardware, each of said plurality of hardware objects including at least one property and at least one method for directly monitoring and/or controlling said hardware device.

47. (Original) The controller of claim 41 wherein said process control program includes a plurality of process objects representing a plurality of process elements and said hardware control program includes a plurality of hardware objects each representing a hardware device from said plurality of process hardware, each of said plurality of process objects including at least one property and at least one method for manipulating one of said plurality of process elements, each of said plurality of hardware objects including at least one property and at least one method for directly monitoring and/or controlling said hardware device, said plurality of process objects communicating with said plurality of hardware objects.

48. (Original) The controller of claim 41 wherein said process control program and said hardware control program execute a process including a step of correlating one of a plurality of devices to one of a plurality of input/output points, whereby a set of data is passed between said process control program and said hardware control program, said process control program dealing with said plurality of devices and said hardware control program dealing with said plurality of input/output points.

49. (Original) The controller of claim 41 wherein said process control program passes a set of data to said hardware control program, said hardware control program

executing a set of instructions manipulating said plurality of process hardware to perform said process flow step defined by said one of said plurality of unit operations.

50. (Original) The controller of claim 41 wherein said process control program executes a step of communicating a recipe state, at least one unit operation state, and at least one device state to a workstation.

51. (Original) The controller of claim 41 wherein said hardware control program performs data acquisition from a plurality of selected devices of said plurality of process hardware.

52. (Cancelled)

53 -55. (Cancelled)

56. (Previously presented) A computer programmed to execute a process for automating a sequence of process flow operations, said process comprising:

receiving a recipe including a plurality of unit operations, each of said plurality of unit operations describing a process flow step in terms of at least one chemical and/or physical step to be performed;_and

executing said plurality of unit operations including the steps of:

executing one of said plurality of unit operations and starting a parallel group, classifying a next one of said plurality of unit operations as one of a parallel operation and a sequential operation,

executing said parallel operation as part of said parallel group and repeating said step of classifying,

continuing execution of said parallel group until each of said plurality of unit operations in said parallel group is complete,

executing said sequential operation and starting a new parallel group, and repeating said step of classifying.

57. (Original) The process of claim 56 further including a step of receiving a reset command and initializing the computer system before said step of receiving said recipe.

58. (Original) The process of claim 56 further including a step of communicating a recipe state, at least one unit operation state, and at least one device state to a workstation.

59. (Original) The process of claim 56 wherein said step of executing one of said plurality of unit operations, said step of executing said parallel operation, and said step of executing said sequential operation each includes a step of passing a set of data to a hardware control module from a process control module, said hardware control module performing a set of instructions manipulating said plurality of process hardware to perform said process flow step.

60. (Original) The process of claim 56 further including a step of performing data acquisition from a plurality of selected devices of a plurality of process hardware, said step of performing data acquisition performed by a hardware control module, said hardware control module sending a plurality of acquired information to a process control module.

61. (Original) The process of claim 56 further including a step of correlating one of a plurality of devices to one of a plurality of input/output points, whereby a set of data is passed between a process control program and a hardware control program, said process control program dealing with said plurality of devices and said hardware control program dealing with said plurality of input/output points.

62. (Previously presented) A program storage device readable by a machine, storing a program of instructions executable by the machine to execute a sequence of process flow operations, said program instructions comprising:

instructions for performing an execution loop wherein a plurality of unit operations, each of said plurality of unit operations describing a process flow step in terms of at

least one chemical and/or physical step to be performed, are executed, said execution loop including the steps of:

- executing one of said plurality of unit operations and starting a parallel group,
- classifying a next one of said plurality of unit operations as one of a parallel operation and a sequential operation,
- executing said parallel operation as part of said parallel group and repeating said step of classifying,
- waiting for said parallel group to complete execution,
- executing said sequential operation and starting a new parallel group, and
- repeating said step of classifying.

63. (Original) The method of claim 62 further including a step of receiving a reset command and initializing a controller before said step of receiving said recipe.

64. (Original) The method of claim 62 further including a step of communicating a recipe state, at least one unit operation state, and at least one device state to a workstation.

65. (Original) The method of claim 62 wherein said step of executing one of said plurality of unit operations, said step of executing said parallel operation, and said step of executing said sequential operation each include a step of passing a set of data to a hardware control module from a process control module, said hardware control module executing a set of instructions manipulating said plurality of process hardware to perform said process flow step.

66. (Original) The method of claim 62 further including a step of using a lookup table correlating one of a plurality of devices to one of a plurality of input/output points, whereby a set of data is passed between a process control program and a hardware control program, said process control program dealing with said plurality of devices and said hardware control program dealing with said plurality of input/output points.

67. (Original) The method of claim 62 further including a step of performing data acquisition from a plurality of selected devices of a plurality of process hardware.

68. (Original) Computer readable media tangibly embodying a program of instructions executable by a computer to perform a method of automating a sequence of process flow operations, said method comprising:

receiving a recipe including a plurality of unit operations, each of said plurality of unit operations describing a process flow step in terms of at least one chemical and/or physical step to be performed; receiving a command to begin execution of said recipe; and

performing an execution loop wherein said plurality of unit operations are executed, said execution loop including the steps of: executing one of said plurality of unit operations, determining if a next one of said plurality of unit operations is executable in parallel with said one of said plurality of unit operations and, if so, executing said next one of said plurality of unit operations and repeating said step of determining until said next one of said plurality of unit operations is determined not to be executable in parallel, and waiting for execution of said one of said plurality of unit operations to be completed if said next one of said plurality of unit operations is determined not to be executable in parallel with said one of said plurality of unit operations.

69. (Original) Media as in claim 68 wherein said method further includes a step of receiving a reset command and initializing a controller before said step of receiving said recipe.

70. (Original) Media as in claim 68 wherein said method further includes a step of communicating a recipe state, at least one unit operation state, and at least one device state to a workstation.

71. (Original) Media as in claim 68 wherein said method further includes a step of using a lookup table to correlate one of a plurality of input/output points to one of a plurality of hardware devices.

72. (Original) Media as in claim 68 wherein said method further includes a step of performing data acquisition from a plurality of selected devices of a plurality of process hardware.

73-75. (Cancelled)

76. (Cancelled)

77. (Original) An interface for processing an automated sequence of process flow operations, the interface comprising computer readable program code devices for:

- accepting a plurality of unit operations forming a recipe;
- accepting an execute command to initiate execution of a loop wherein said plurality of unit operations are executed, said loop including the steps of:
 - executing one of said plurality of unit operations and starting a parallel group,
 - classifying a next one of said plurality of unit operations as one of a parallel operation and a sequential operation,
 - executing said parallel operation as part of said parallel group and repeating said step of classifying,
 - waiting for said parallel group to complete execution,
 - executing said sequential operation and starting a new parallel group, and
 - repeating said step of classifying; and
 - sending a data stream including a recipe state, a unit operation state, and at least one device state.

78. (Cancelled)

79. (Previously presented) The computer system of claim 24, wherein said processing component includes a data structure comprising:

- a list table containing a set of recipe data including a list of at least one recipe;

a recipe table containing a set of unit operation data including a list of a plurality of unit operations, said recipe table containing a set of recipe live data, said recipe live data including a recipe status, a recipe start time and date, and a recipe finish time and date; and

a unit operation table containing a set of parameters relating to each of said plurality of unit operations, said unit operation table containing a set of unit operation live data, said unit operation live data including a unit operation status, a unit operation start time and date, and a unit operation finish time and date.

80. (Previously presented) The computer system of claim 24, further comprising a workstation performing the steps of:

presenting to the user a first list of a plurality of available unit operations;

presenting to the user a recipe list of a plurality of selected unit operations defining said recipe;

presenting to the user a resource list including a plurality of resources based on said plurality of selected unit operations;

allowing the user to add at least one of said plurality of available unit operations to said recipe list;

allowing the user to delete at least one of said plurality of available unit operations from said recipe list; and

allowing the user to edit the resources for one of said plurality of selected unit operations.

81. (Cancelled)